수직배향된 산화아연 나노막대의 성장 및 발광특성에 관한 연구

Metalorganic vapor-phase epitaxial growth of vertically well-aligned ZnO nanorods and their photoluminescent properties

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1. Introduction

One-dimensional semiconductor nanowires and nanorods have attracted increasing interest due to their unique physical properties and diversity for potential electronic and photonic device applications., Unlike the conventional nanowires fabricated by metal catalyst-assisted vapor-liquid-solid (VLS) method, we developed metalorganic vapor-phase epitaxial (MOVPE) growth for which no catalyst is needed. The structural and photoluminecent properties will also be discussed.

2. Result and Discussion

(1) Growth of vertically-well aligned ZnO nanorods

ZnO nanorods were grown on sapphire (0001) substrates using low pressure MOVPE system. For ZnO nanorod growth, diethylzinc (DEZn) and oxygen were employed as the reactants and argon was used as a carrier gas. Oxygen and DEZn flow rates were in the range of 20-100 and 0.5-5 sccm at a DEZn bubbler temperature of -15℃respectively. Typical growth temperature was in the range of 400-500℃. Prior to ZnO nanorod growth, very thin ZnO buffer layers were grown at a room temperature.

(2) Morphology of ZnO nanorods

Field emission scanning electron microscopy (FE-SEM) clearly revealed the general morphology of the ZnO nanorods. Fig. 1(a) and 1(b) shows the images of ZnO nanorods grown for 1 hr. The ZnO nanorods are well aligned vertically, showing uniformity in their diameters, lengths, and densities.

(3) Photoluminescent properties of the ZnO nanorods

The optical properties of the ZnO nanorods were investigated by photoluminescence (PL) spectroscopy. At room temperature, the dominant peak was observed at 3.29 eV, which is attributed to the free exciton peak. The FWHM of the free exciton peak was as narrow as 90 meV. The deep

level green emission associated with point defects commonly observed in ZnO epilayers was found to be extremely weak compared to the near band-edge emission. The strong and sharp excitonic emission and low deep level emission indicate that the ZnO nanorods are of excellent optical quality.

3. Conclusion

MOVPE growth technique enabled the epitaxial growth of vertically aligned ZnO nanorods without using metal catalyst. The FE-SEM images showed uniform thickness and length distributions. From PL measurements, strong and sharp excitonic emission at room temperature was observed at 3.29 eV, along with a very weak deep level emission.

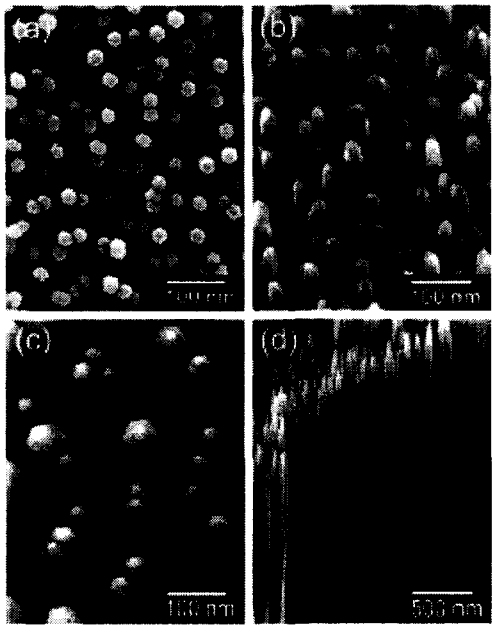

Fig. 1. FE-SEM (a) plan-view and (b), (c), (d) tilted images

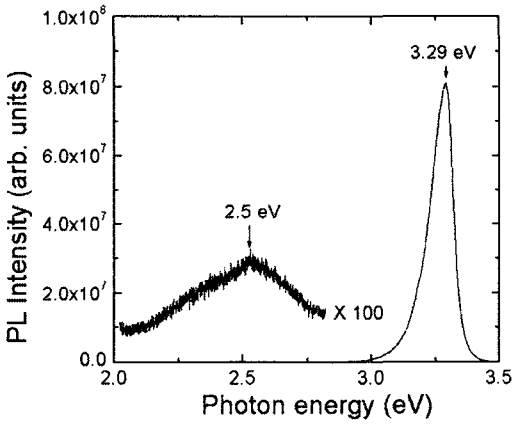

Fig. 2. PL spectrum of ZnO nanorods measured at room temperature. A dominant free exciton peak was observed at 3.29 eV. Deep level emission is also shown to be extremely weak.

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